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Model of collective motion of motors in muscle oscillations

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In general, the contractile unit of muscle takes one of two states, relaxation or contraction. The contraction results from relative sliding of the thick (myosin) and thin (actin) filaments in sarcomere, which is the contractile unit of striated muscle. In the state of SPontaneous Oscillatory Contraction (SPOC), sarcomeres repeat slow shortening and quick extension spontaneously [Okamura,N. and Ishiwata,S., J.Muscle Res.Cell Motil. 9, 111-119(1988).]. How does such a regular oscillation occur when many molecular motors, which function as a stochastic nano-machine, are assembled? It seems to be difficult to explain SPOC in the conventional framework of muscle contraction. Recently, a new advance in non-equilibrium statistical mechanics has been made on describing fluctuations in systems at and out of equilibrium. These results have been applied to the modeling of biological molecular motors such as rotary F1-ATPase motor and linear myosin-actin motors [Gaspard, P., Prog. Theor. Phys. Supp. in press (2006)]. In this model, the stochastic process is formulated by a set of coupled Fokker-Planck equations containing biased diffusion and random jumps between some chemical states. To understand the SPOC mechanism, we modify this model. Here we take into account the experimental observations of SPOC and single-molecular behavior under external load to this modified model and try to explain the collective mode of motion observed in an assembly of myosin motors.